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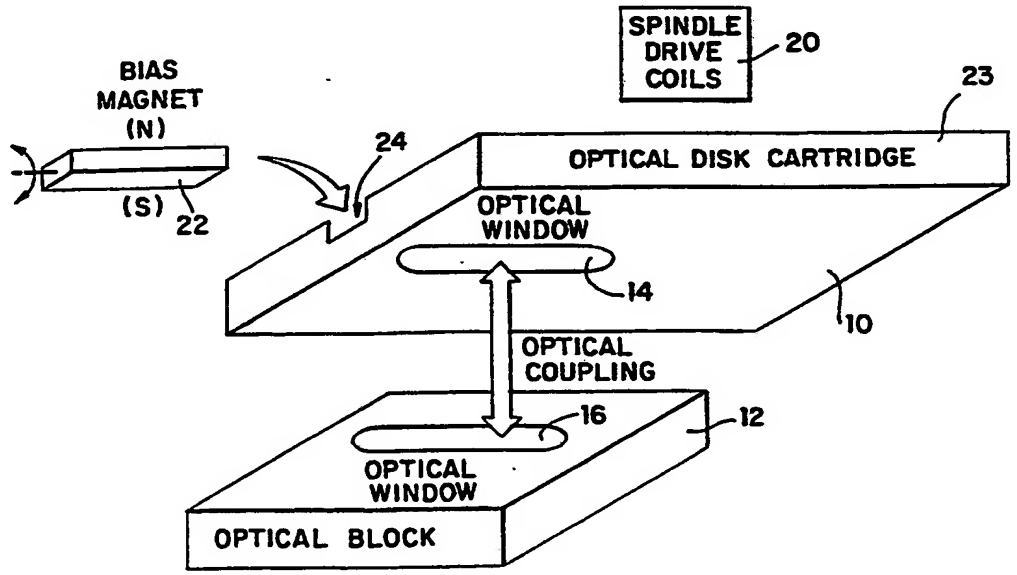
(54) Title: CONNECTORLESS HERMETIC OPTICAL DISK SYSTEM



(57) Abstract

An optical disk system includes a hermetically sealed optical disk cartridge (10) and a hermetically sealed optical block (12) each having overlying optical windows (14 and 16) for coupling laser light from the optical block (12) to the optical disk contained in the cartridge (10). A split spindle motor is employed with a spindle rotor magnet (44) contained in the optical disk cartridge (10) and spindle drive coils (20) disposed outside of the cartridge (10) so that the optical disk cartridge (10) needs no mechanical or electrical connections. The optical block (12) contains the optical head (68) and, in one embodiment, the seek motor (70) so as to protect the optics (64) as well as the tracking and focusing actuators (66) from contaminants.

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CONNECTORLESS HERMETIC OPTICAL DISK SYSTEM

FIELD OF THE INVENTION

The present invention relates to an optical disk system and more particularly to such a data storage and retrieval system that includes a connectorless, hermetically sealed optical disk cartridge and a hermetically sealed optical block each having an optical window for coupling laser light from the optical block, through the hermetic barriers of the block and cartridge housings to the optical disk contained in the cartridge.

BACKGROUND OF THE INVENTION

Optical disk systems are known that include an optical disk media for storing data and a drive mechanism for reading data from and/or writing data to the optical disk media. The drive mechanism typically includes an optical head with an objective lens and seek, tracking and focus actuators; a spindle motor; and a disk coupling. Salt deposits, water condensation, dust and/or fungus can corrode or contaminate the surfaces of the objective lens and other optics resulting in excessive loss of laser signal power along the optical path to the optical disk media. Further, contaminants collecting in the tracking and focus actuators may degrade performance and, after a period of time, may cause the actuators to freeze. The optical disk media may also be adversely affected

by contaminants in the environment. The optical disk media typically employs a rare earth material for the sensitive layer wherein such materials corrode easily when exposed to high temperatures in conjunction with high humidity. Such contamination can result in data errors which, in certain applications, cannot be tolerated.

SUMMARY OF THE INVENTION

In accordance with the present invention, the disadvantages of prior art optical disk systems, as discussed above, have been overcome. The optical disk system of the present invention employs a hermetically sealed optical disk cartridge and a separate hermetically sealed optical block in order to protect the optical disk and the optical elements as well as the tracking and focus actuators from salt, fog, humidity, sand, dust and fungus.

More particularly, the optical disk cartridge includes a hermetically sealed housing with an optical disk for storing data mounted on a spindle shaft in the housing. A rotor magnet is coupled to the spindle shaft in the hermetically sealed housing for rotating the shaft and the optical disk in response to a magnetic drive field applied external to the housing by spindle drive coils. An optical window sealed in a wall of the housing allows laser light to pass through the housing window to the optical disk to allow data to be read from, erased, or written to the optical disk while retaining the housing seal.

The split motor with the magnetic drive field generated externally to the cartridge housing requires no mechanical linkages or electrical connections to the optical disk cartridge. Further, the motor's heat dissipation is outside of the optical disk cartridge. A bias magnet, employed to control the write and erase operations of the optical disk cartridge, is disposed external to the optical disk

cartridge but, as the split motor, the bias magnet requires no mechanical linkages or electrical connections to the optical disk cartridge.

The cartridge housing is a box-like structure that provides the rigidity necessary to support the optical disk in a high "g" environment. Further, the spindle shaft is rigidly supported and secured to each of two halves of the box-like housing so as to assure consistently tight angular and axial control of the optical disk when subjected to high "g" forces and various mounting altitudes if the optical disk system is employed in an aircraft.

The optical block includes a hermetically sealed housing with an optical window sealed in a wall of the housing to allow laser light to pass through the housing window. The optical window of the optical block overlays the optical window of the optical disk cartridge so as to allow the laser from the optical block to reach all necessary areas of the optical disk. The optics and actuators for focusing and tracking the laser onto a particular track of the optical disk are also contained in the hermetically sealed housing of the optical block. In one embodiment the seek motor that moves the tracking and focusing apparatus with respect to the optical window disposed in the optical disk cartridge is contained in the hermetically sealed housing of the optical block. In a second embodiment, however, the seek motor is disposed outside of the hermetically sealed housing of the optical block.

These and other objects, advantages and novel features of the present invention, as well as details of an illustrated embodiment thereof, will be more fully understood from the following description and the drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a block diagram of the connectorless hermetic optical disk system of the present invention;

FIG. 2 is an exploded view of the optical disk cartridge shown in FIG. 1;

FIG. 3 is a partial cross-sectional view of the optical disk cartridge, bias magnet, spindle drive coil and bias magnet drive coil assemblies shown in FIG. 1;

FIG. 4 is an enlarged cross-sectional view of the spindle motor components contained in the optical disk cartridge as shown in FIG. 3;

FIG. 5 is a block diagram of one embodiment of the optical block shown in FIG. 1; and

FIG. 6 is a block diagram of a second embodiment of the optical block.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The connectorless hermetic optical disk system of the present invention as shown in FIG. 1 includes a hermetically sealed optical disk cartridge 10 and a hermetically sealed optical block 12 each of which includes a respective optical quality high-strength glass window 14 and 16 for coupling laser light through the hermetic barriers of the housings of the cartridge 10 and block 12. The optical windows 14 and 16 overlie each other so as to allow a laser from the optical block 12 to reach all necessary areas of an optical disk 18 contained in the optical disk cartridge 10.

The hermetically sealed optical disk cartridge 10 includes only an optical disk 18 for storing data on a number of radial tracks and half of the spindle motor for rotating the optical disk 18 as shown in detail in FIGS. 2-4. The magnetic drive field 19 for actuating the spindle motor half contained in the optical disk cartridge 10 is generated by

spindle drive coils 20 disposed outside of the optical disk cartridge 10. A bias magnet 22 that controls the write and erase operations of the optical disk system is also located external to the optical disk cartridge 10. More particularly, the bias magnet 22 is received in a recess 24 formed in the housing 23 of the optical disk cartridge 10 directly opposite to the optical window 14. The magnetic drive field 18 from the drive coils 20 as well as the bias magnetic field from the bias magnet 22 are coupled through the housing 23 of the optical disk cartridge 10 so that no mechanical linkages or electrical connections are required enabling the optical disk cartridge 10 to be connectorless. Further, the heat generated by the spindle drive coils is also outside of the optical disk cartridge 10. Because the hermetically sealed optical disk cartridge 10 contains only the optical disk 18 and half of the spindle motor, the optical disk cartridge 10 is both small and inexpensive.

The hermetically sealed optical block 12 includes the optical elements such as the objective lens, laser, and focus and tracking actuators. In a first embodiment depicted in FIGS. 1 and 5, the optical block 12 also includes a seek motor disposed therein to move the objective lens linearly along the optical window 16 so that different tracks of the optical disk 18 contained in the optical disk cartridge 10 may be accessed. In a second embodiment shown in FIG. 6, the seek motor is disposed outside of the optical block 12.

The optical disk cartridge 12 as shown in detail in FIG. 2 includes a housing 23 formed of a top housing member 26 and a bottom housing member 28 sealed together to form a box-like structure that provides the rigidity necessary to support the optical disk 18 in high "g" environments. The top and the bottom housing members 26 and 28 are formed of aluminum

wherein a flexible epoxy 30 capable of withstanding a wide temperature range forms a hermetic gasket between the aluminum housing members 26 and 28. The optical window 14 is installed on a bed of RTV or any suitable adhesive so as to provide a complaint hermetic seal between the thermally mismatched materials of aluminum and glass respectively forming the top housing member 26 and the optical window 14. A window cover 32, slidable with respect to the optical window 14 in the top housing member 26, is provided to protect the optical window 14 from fingerprints and the like during handling of the optical disk cartridge 12.

The spindle shaft assembly for the optical disk 18, as shown in FIGS. 2-5 includes a spindle shaft 34. The spindle shaft 34 is rigidly supported between the top housing member 26 and the bottom housing member 28 of the box-like housing structure with the optical disk 18 fixed to the spindle shaft 34 by means of a hub 36 and duplex bearings 38 so as to assure consistently tight angular and axial control of the optical disk 18 when subjected to high "g" forces and various mounting altitudes. More particularly, a pair of screws 40 and 42 secure the spindle shaft 34 to the top housing member 26 and the bottom housing member 28 respectively. The optical disk 18 is coupled to the spindle shaft 34 by the duplex bearings 38 to provide sufficient stiffness to overcome optical disk imbalance and thereby allow high spin rates to achieve a desired data transfer rate. The bearings 38 are preferable matched to provide very accurate control over disk runout and wobble.

The optical disk 18 is preferable a thermo magneto erasable optical disk. The optical disk 18 is secured to the hub 36 by an adhesive such as RTV. Secured to the opposite side of the hub 36 is a rotor magnet ring 44 that is preferably a rare earth magnet, the hub 36 being formed of a magnetic shunt material so as to complete the

motor's magnetic path and contain stray magnetic fields from the rotor magnet 44. An insert 46 of a nonmagnetic material, such as nonmagnetic stainless steel, is sealed in an aperture 48 in the bottom housing member 28. The nonmagnetic insert 46 disposed in the region in which the magnetic drive field 19 is coupled to the rotor magnet 44, reduces eddy current loss in the coupling region to thereby improve the efficiency of the spindle motor. In the presence of a magnetic drive field 19, the rotor magnet 44 rotates causing the hub 36 and the optical disk 18 secured thereto to rotate also.

As shown in greater detail in FIG. 4, a spring washer and shim 48 are provided to preload the spindle shaft 34 and hub assembly. A shim 50 disposed between the head 52 of the spindle shaft 34 and the duplex bearings 38 is provided for height adjustment. Further, O-rings 54 and 56 provide respective seals between the spindle shaft 34 and the top housing member 26 as well as between the spindle shaft 34 and the insert 46 disposed in the bottom housing member 28.

The bias magnet 22 is mounted by means of a pair of ball bearing 58 and 60 to a portion of a drive housing (not shown) or the like to that the magnet 22 may be received in the recess 24. The recess 24 for the bias magnet 22, as well as the optical window 14, are disposed adjacent to the optical disk 18 along a radius thereof so that data may be read from, recorded on or erased from each of the radial tracks of the optical disk 18. Depending upon the orientation of the bias magnet 22 as controlled by a bias magnet coil and shunt assembly 61, the optical disk 18 may be operated as a read-only memory (ROM), a write-once memory (WORM) or as a full read-write-erase memory. For ROM operation, the bias magnet 22 is locked in a neutral position wherein no bias magnetic field is applied or the bias magnet 22 is removed altogether so that both the write and erase

operations are inhibited. For a WORM operation, the bias magnet 22 is locked into a write bias polarity position or is allowed to be rotated between the neutral and write bias polarity positions so that only the erase operation is inhibited. For full read-write-erase memory operation, the bias magnet 22 is allowed to rotate between neutral, write bias, and erase bias polarity positions. It is noted that an electromagnetic coil may be employed instead of the bar magnet 22 to control the write and erase operations as discussed above wherein the coil further provides bulk erasure capabilities.

As shown in FIG. 5, a first embodiment of the optical block 12 includes a hermetically sealed housing 62 containing an optical head 68 with the objective lens 64, focus and tracking actuators 66, the laser and detectors as well as a seek motor 70. The seek motor 70 moves the optical head 68 linearly along the optical window 16 so as to access the data on various tracks of the optical disk 18. In a second embodiment as shown in FIG. 6, the optical block 12 includes a hermetically sealed housing 72 that contains only the optical head 78 with the objective lens 74, focus and tracking actuators 76, laser and detectors. The seek motor 80 is disposed outside of and coupled to the optical block housing 72 by a seek actuator 82. In both the first and second embodiments, the optics and focus and tracking actuators are contained in a hermetic housing 62, 72 so as to be protected from contaminants.

The connectorless hermetic optical disk system of the present invention protects susceptible components thereof from the environment, particularly from salt, fog, humidity, sand, dust and fungus, while providing an optical disk cartridge 10 that is small and inexpensive.

Many modifications and variations of the present invention are possible in light of the above teachings. Thus, it is to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as discussed hereinabove.

What is claimed and desired to be secured by Letters Patent is:

1. A data storage device comprising:

a hermetically sealed housing;

an optical disk for storing data mounted for rotation in said housing;

means coupled to said optical disk in said housing for rotating said optical disk in response to a drive field applied external to said housing; and

an optical window sealed in a wall of said housing to allow laser light to pass through said housing window to said optical disk.

2. A data storage device as recited in claim 1 wherein said optical disk is fixedly secured to a spindle shaft, said spindle shaft being rigidly secured to said housing.

3. A data storage device as recited in claim 2 wherein said housing includes a top member and a bottom member, said spindle shaft being rigidly secured to said top and bottom members.

4. A data storage device as recited in claim 1 wherein said rotating means includes a rotor magnet responsive to an external magnetic drive field coupled to said rotor magnet through a wall of said housing.

5. A data storage device as recited in claim 4 wherein said housing includes a nonmagnetic member sealed in said housing wall for coupling said magnetic drive field to said rotor magnet.

6. A data storage device as recited in claim 1 wherein said optical window is sealed in a first wall of said housing, said housing having a second wall opposite said first wall with a recess

formed in said second wall opposite to said window to accommodate a bias magnet therein.

7. A data storage device as recited in claim 1 wherein said optical disk is a thermo magneto optical disk.

8. A data storage device comprising:

a hermetically sealed housing;

an optical disk for storing data mounted on a spindle shaft in said housing;

a rotor magnet coupled to said spindle shaft in said housing for rotating said shaft and said optical disk in response to a magnetic drive field applied external to said housing; and

an optical window sealed in a wall of said housing to allow laser light to pass through said housing window to said optical disk.

9. A data storage device as recited in claim 8 wherein said housing includes a top member and a bottom member and said spindle shaft is rigidly secured to said top member and said bottom member.

10. A data storage device as recited in claim 8 including a hub to which said rotor magnet is secured; and a pair of bearings for coupling said hub to said spindle shaft.

11. A data storage device as recited in claim 10 wherein said bearings are matched.

12. A data storage device as recited in claim 10 wherein said hub forms a magnetic shunt.

13. A data storage device as recited in claim 8 wherein said housing includes a nonmagnetic

member forming at least a portion of a wall of said housing adjacent to said rotor magnet for coupling said magnetic drive field to said rotor magnet.

14. A data storage device as recited in claim 8 wherein said optical window is sealed in a first wall of said housing, said housing having a second wall opposite said first wall with a recess formed in said second wall opposite to said window to accommodate a bias magnet therein.

15. A data storage device as recited in claim 8 wherein said optical disk is a thermo magneto optical disk.

16. An optical disk system comprising:

a first hermetically sealed housing;

an optical disk having a plurality of tracks for storing data, said disk being mounted for rotation in said first sealed housing;

means coupled to said optical disk in said first housing for rotating said optical disk;

a first optical window sealed in a wall of said first housing to allow laser light to pass through said first housing window to said optical disk;

a second hermetically sealed housing;

a second optical window sealed in a wall of said second housing to allow laser light to pass through said second housing window;

means mounted in said second sealed housing for focusing a laser through said first and second windows onto said optical disk; and

means for moving said focusing means with respect to said first optical window.

17. An optical disk system as recited in claim 16 wherein said rotating means includes a rotor

magnet coupled to said optical disk in said housing, said rotor magnet being responsive to a magnetic drive field applied external to said housing.

18. An optical disk system as recited in claim 17 including a nonmagnetic insert sealed in a wall of said housing for coupling said magnetic drive field to said rotor magnet.

19. A data storage device as recited in claim 16 wherein said optical window is sealed in a first wall of said housing, said housing having a second wall opposite said first wall with a recess formed in said second wall opposite to said window to accommodate a bias magnet therein.

20. A data storage device as recited in claim 18 wherein said optical disk is a thermo magneto optical disk.

21. An optical disk system as recited in claim 16 wherein said first optical window overlies said second optical window.

22. An optical disk system as recited in claim 16 wherein said moving means is coupled to the outside of said second housing.

23. An optical disk system as recited in claim 16 wherein said moving means is contained within said second housing.

AMENDED CLAIMS

[received by the International Bureau on 8 December 1989 (08.12.89)
original claims 1-23 replaced by amended claims 1-31 (6 pages)]

1. A data storage device comprising:

a hermetically sealed housing formed of a first material;

an optical disk for storing data mounted for rotation in said housing;

means coupled to said optical disk in said housing for rotating said optical disk in response to a drive field applied external to said housing;

an optical window formed of a second material that responds to temperatures differently than said first material, said optical window being sealed in a wall of said housing to allow laser light to pass through said housing window to said optical disk; and

means for providing a compliant hermetic seal to seal said optical window in said housing wall.

2. A data storage device as recited in claim 1 wherein said optical disk is fixedly secured to a spindle shaft assembly having a spindle shaft, said spindle shaft being rigidly secured to said housing.

3. A data storage device as recited in claim 2 wherein said housing includes a top member and a bottom member, said spindle shaft being rigidly secured to said top and bottom members.

4. A data storage device as recited in claim 1 wherein said rotating means includes a rotor magnet responsive to an external magnetic drive field coupled to said rotor magnet through a wall of said housing, said rotor magnet being mounted on a hub supporting said optical disk and said hub being coupled by at least one bearing to a spindle shaft rigidly secured to said housing.

5. A data storage device as recited in claim 4 wherein the first material of said housing is a metal, said housing including a nonmagnetic member hermetically sealed in said housing wall for coupling said magnetic drive field to said rotor magnet.

6. A data storage device as recited in claim 1 wherein said optical window is sealed in a first wall of said housing, said housing having a second wall opposite said first wall with a recess formed in said second wall opposite to said window to accommodate a bias magnet therein.

7. A data storage device as recited in claim 1 wherein said optical disk is a thermo magneto optical disk.

8. A data storage device comprising:

a hermetically sealed housing;

an optical disk for storing data mounted on a spindle shaft in said housing formed of a first material;

a rotor magnet coupled to said optical disk in said housing for rotating said optical disk in response to a magnetic drive field applied external to said housing;

an optical window formed of a second material that responds to temperatures differently than said first material, said optical window being sealed in a wall of said housing to allow laser light to pass through said housing window to said optical disk; and

means for providing a compliant hermetic seal to seal said optical window in said wall.

9. A data storage device as recited in claim 8 wherein said housing includes a top member and a bottom member and said spindle shaft is rigidly secured to said top member and said bottom member.

10. A data storage device as recited in claim 8 including a hub to which said rotor magnet is secured; and a pair of bearings for coupling said hub to said spindle shaft.

11. A data storage device as recited in claim 10 wherein said bearings are matched.

12. A data storage device as recited in claim 10 wherein said hub forms a magnetic shunt.

13. A data storage device as recited in claim 8 wherein said first material of said housing is a metal and said housing includes a nonmagnetic member forming at least a portion of a wall of said housing adjacent to said rotor magnet for coupling said magnetic drive field to said rotor magnet.

14. A data storage device as recited in claim 8 wherein said optical window is sealed in a first wall of said housing, said housing having a second wall opposite said first wall with a recess formed in said second wall opposite to said window to accommodate a bias magnet therein.

15. A data storage device as recited in claim 8 wherein said optical disk is a thermo magneto optical disk.

16. An optical disk system comprising:

a first hermetically sealed housing;

an optical disk having a plurality of tracks for storing data, said disk being mounted for rotation in said first sealed housing;

means coupled to said optical disk in said first housing for rotating said optical disk;

a first optical window hermetically sealed in a wall of said first housing to allow laser light to pass through said first housing window to said optical disk;

a second hermetically sealed housing;

a second optical window hermetically sealed in a wall of said second housing to allow laser light to pass through said second housing window;

means mounted in said second sealed housing for focusing a laser through said first and second windows onto said optical disk; and

means for moving said focusing means with respect to said first optical window.

17. An optical disk system as recited in claim 16 wherein said rotating means includes a rotor magnet coupled to said optical disk in said housing, said rotor magnet being responsive to a magnetic drive field applied external to said housing.

18. An optical disk system as recited in claim 17 including a nonmagnetic insert hermetically sealed in a wall of said housing for coupling said magnetic drive field to said rotor magnet.

19. A data storage device as recited in claim 16 wherein said optical window is sealed in a first wall of said housing, said housing having a second wall opposite said first wall with a recess formed in said second wall opposite to said window to accommodate a bias magnet therein.

20. A data storage device as recited in claim 18 wherein said optical disk is a thermo magneto optical disk.

21. An optical disk system as recited in claim 16 wherein said first optical window overlies said second optical window.

22. An optical disk system as recited in claim 16 wherein said moving means is coupled to the outside of said second housing.

23. An optical disk system as recited in claim 16 wherein said moving means is contained within said second housing.

24. A data storage device as recited in claim 1 wherein said wall is formed of aluminum and said optical window is formed of glass.

25. A data storage device as recited in claim 5 wherein said housing is formed of aluminum and said nonmagnetic member is formed of nonmagnetic stainless steel.

26. A data storage device as recited in claim 1 including means for covering said optical window to protect said window from the environment, said covering means being formed of said first material.

27. A data storage device as recited in claim 8 wherein said wall is formed of aluminum and said optical window is formed of glass.

28. A data storage device as recited in claim 8 including means for covering said optical window to protect said window from the environment, said covering means being formed of said first material.

29. An optical block for reading data stored on an optical disk comprising:

a hermetically sealed housing;

an optical window hermetically sealed in a wall of said housing to allow laser light to pass therethrough;

means mounted in said housing for focusing a laser through said optical window; and

means for moving said focusing means with respect to an optical disk to read data stored thereon.

30. An optical block as recited in claim 29 wherein said moving means is coupled to the outside of said housing.

31. An optical block as recited in claim 29 wherein said moving means is contained within said hermetically sealed housing.

Fig. 1

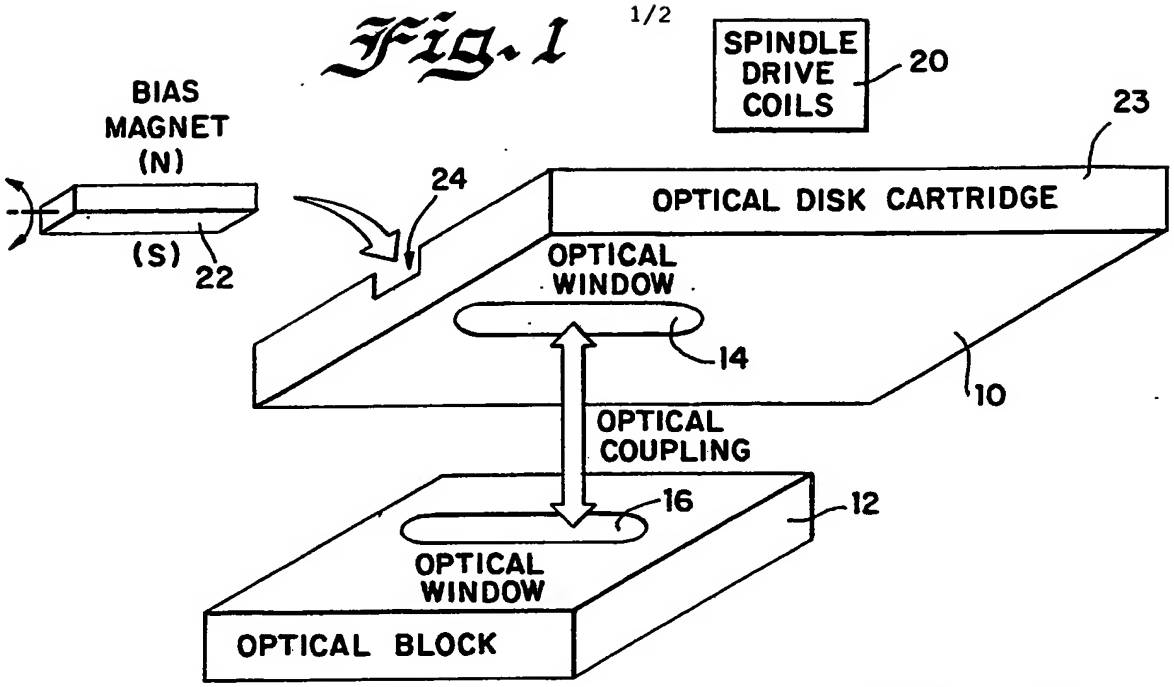
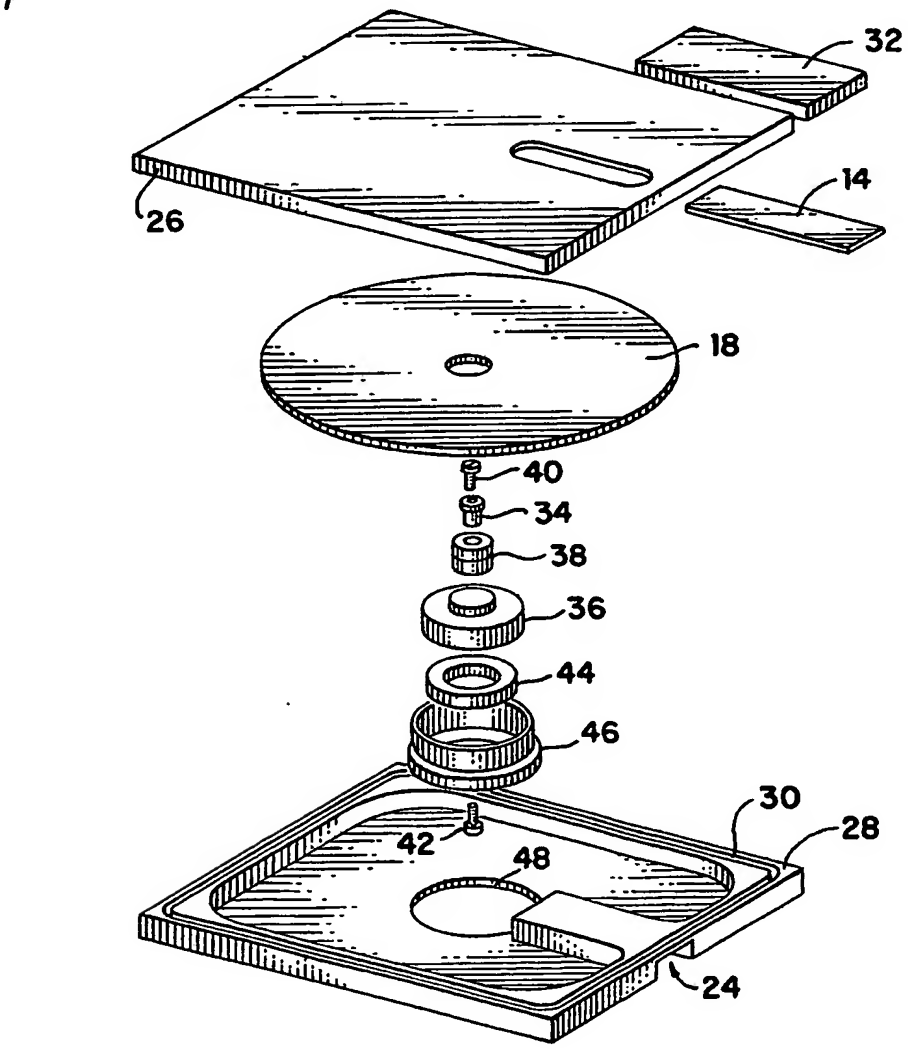

SPINDLE DRIVE COILS
20
BIAS MAGNET (N)
(S)
22
24
23
OPTICAL DISK CARTRIDGE
OPTICAL WINDOW
14
10
OPTICAL COUPLING
16
12
OPTICAL WINDOW
OPTICAL BLOCK

Fig. 2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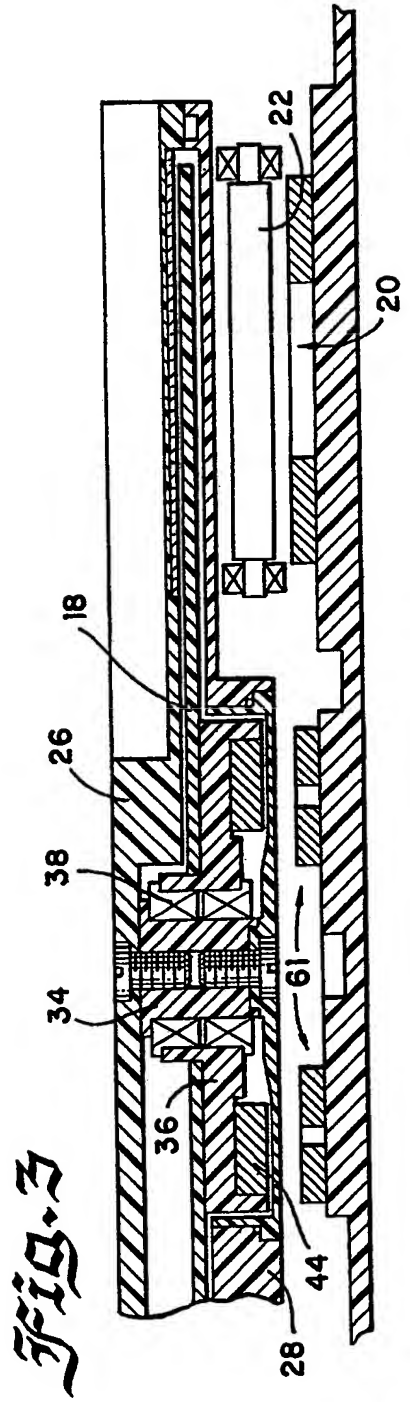

FIG. 3

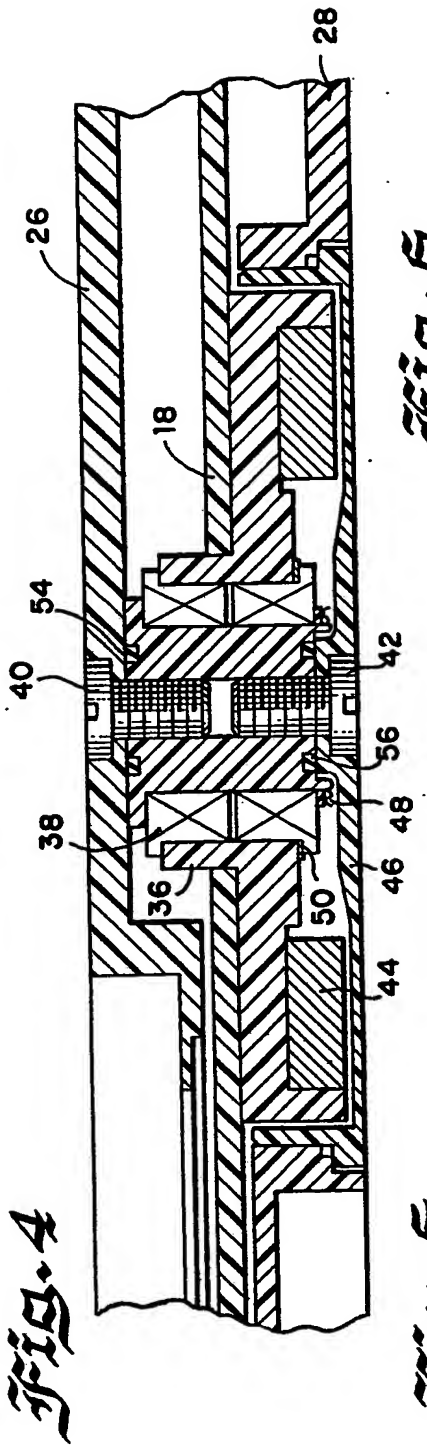

FIG. 4

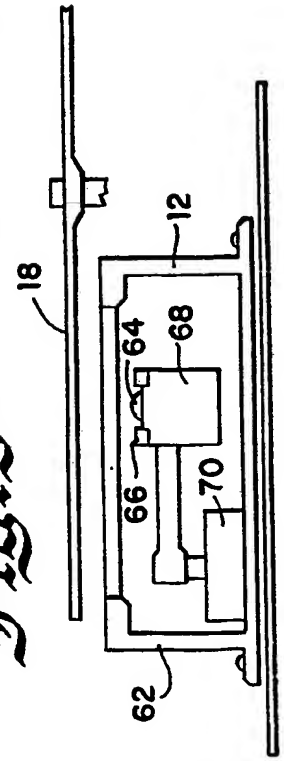

FIG. 5

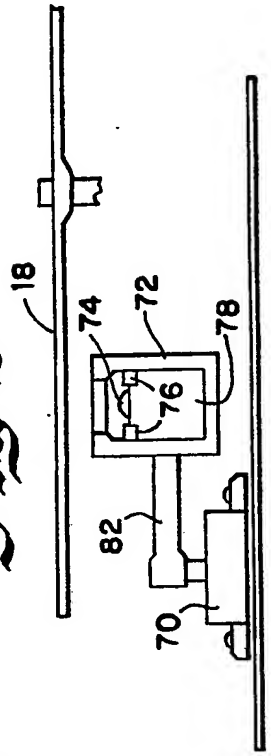

FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/US89/03723

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(4): G11B 7/00; G11B 23/02

U.S. CL: 369/13, 271, 291; 360/133; 206/309, 312

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	369/291, 12, 270, 271; 360/133; 206/309, 312, 444

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X Y	US, A, 4,535,434 (KISHI) Published 13 AUGUST 1985 A11	1-5,8-13,16-18,21, 23,6, 7,14,15, 19, 20
A	US, A, 4,542,495 (ZIEGLER et al.) Published 17 SEPTEMBER 1985 A11	
A	JA, A, 0054641 (TAKAHASHI) Published 14 MAY 1981 A11	
Y	US, A, 4,740,937 (WATANABE) Published 26 APRIL 1988 A11	6,7,14,15,19,20

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

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IV. CERTIFICATION

Date of the Actual Completion of the International Search: 17 OCTOBER 1989

Date of Mailing of this International Search Report: 15 NOV 1989

International Searching Authority: ISA/US

Signature of Authorized Officer: STEVEN L. STEPHAN

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